Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Natural transition to turbulence in polymeric channel flow SANG JIN LEE, Imperial College London, TAMER ZAKI, Johns Hopkins University — Natural transition in viscoelastic channel flow is investigated using direct numerical simulations (DNS), where the polymer is modeled using the FENE-P constitutive equations. The computations capture the amplification of the primary two-dimensional Tollmien-Schlichting (TS) waves, their secondary instability and ultimately the onset of turbulence. Various Weissenberg numbers (Wi) are simulated in order to assess the influence of elasticity. As Wi is increased, the primary TS waves initially become more linearly unstable, but are subsequently stabilized at higher Wi. This trend suggests that elasticity can either promote or delay transition to turbulence, and the DNS substantiate this prediction. In order to isolate the effect of the polymer on the secondary instability process, simulations are performed for a set of elastic parameters where the primary TS wave has the same linear growth rate as the Newtonian configuration. As a result, while the linear disturbance amplification is similar in the viscoelastic and Newtonian flows, the nonlinear saturated state of the TS waves differs in the two cases, as well as their secondary instability and breakdown to turbulence. The changes in the transition process are examined by analyzing the disturbance energy budget and spectra.

Sang Jin Lee
Imperial College London

Date submitted: 31 Jul 2015 Electronic form version 1.4